STATE OF NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION

MICHAEL F. EASLEY
GOVERNOR

LYNDO TIPPETT
SECRETARY

July 15, 2005

Memorandum

To: Holders of the Traffic Management & Signal Systems Design Manual
Private Engineering Firms and Municipality Traffic Engineers

From: G. A. Fuller, PE
State ITS and Signals Engineer

Subject: Vehicle Clearance Interval Timing Calculations (Std. No. 5.2.2)

Please find attached revised pages on the subject matter for the Traffic Management & Signal Systems Design Manual. These revisions adopt practices recommended by a NCSITE Traffic Engineering Council Task Force and are effective August 1, 2005.

This design practice for the calculation of vehicle clearance interval timings at signalized intersections along the state highway system will supersede the practice implemented on December 15, 2004. Clearance intervals for existing signalized intersections and final traffic signal plans prior to August 1, 2005 do not need to be recalculated. Rather, clearance intervals will be recalculated upon the preparation of revised traffic signal plans for future improvements. As with any other design practice, engineering judgment must be used to ensure site specific needs are met.

Also attached is a copy of the memorandum from the NCSITE Task Force summarizing the recommendations.

The complete Traffic Management & Signal Systems Design Manual is available at the following web page: http://www.doh.dot.state.nc.us/preconstruct/traffic/tmssu/default.htm

If I may be of any further assistance in this matter, please contact me at (919) 733-8021.

Attachments

GAF/REM

Cc: J. Kevin Lacy, PE
Division Traffic Engineers
Regional Traffic Engineers

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Greg A. Fuller, P.E.
State ITS and Signals Engineer
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Dear Mr. Fuller;

The purpose of this memo is to summarize the work of the 2005 NCSITE Task Force for Yellow and Red Intervals. In light of input received upon the strict implementation of the ITE formula in North Carolina in July of 2004, this Task Force was charged with reviewing the NCDOT Signals & Geometrics practice for the calculations and recommending a standard practice statewide. Note: a general familiarity with the ITE formula and the current Signals and Geometrics Section Design Manual is assumed in this letter.

The Task Force was made up of 31 volunteers from NCDOT, municipalities, consultants and not-for-profit organizations. The Task Force met four times in the last five months; individual committees had additional meetings and teleconferences. The committees were charged with in-depth investigation of selected elements of the change/clearance time topic.

The committee chairpersons were:

Clearance Interval Constraints - Richard Mullinax (NCDOT)
Numerical Inputs to ITE Formula - Melissa Cooney (PBS&J)
General Clearance Issues - Bo Winstead (HNTB)
Speed Issues - Pam Alexander (NCDOT)

The following bullets summarize the conclusions of the Task Force:

- That calculation of the yellow change and red clearance intervals should not vary based on the presence or absence of enforcement devices;
- That a combination of NCDOT design practices and the realities of traffic congestion are producing larger, wider intersections that pose challenges for maintaining reasonable clearance times;
- That separate practices should <u>not</u> exist for
    - o different regions of the state,
    - o unique vehicle streams (e.g., high % heavy vehicles),
    - o left turning vehicles versus through vehicles;

- That the ITE formula for the calculation of the total clearance interval should be the basis for the NCDOT practice. The formula as published in the ITE Traffic Engineering Handbook is as follows, broken up into two terms:

$$Y = t + \frac{v}{2a + 2Gg} \qquad AR = \frac{w + L}{v}$$

Yellow Change Interval formula ("1st Term")

- That the 2001 AASHTO constants for deceleration (11.2 ft/sec^2), and perception/reaction time (1.5 sec) are sound;
- That the effect of positive grade should be factored into the yellow calculation;
- That 3.0 seconds should be a minimum value for Yellow;
- That the Signals and Geometrics Section's current practice for selection of vehicle speeds, "v", was reviewed and retained in this application (also applicable to the red clearance interval calculation);
- That the proposed implementation of a yellow change interval of longer than 6.0 seconds is cause for a "stakeholder discussion" to provide advance notification and involvement to stakeholders and to provide an opportunity to consider possible countermeasures.

Red Clearance Interval formula ("2nd Term")

- That 1.0 second should be a minimum value for Red;
- That the strict use of the ITE formula (when compared to past NCDOT practice) is likely to cause a significant shift in allocation of time from yellow to red that may cause motorists to disrespect the red interval;
    - That, therefore, equal consideration should be given to clearing the vehicle through the intersection and limiting "excessive red time" (defined by the Task Force to be greater than 3.0 seconds), thus encouraging driver respect of indications;
- That certain revisions to this formula are recommended; they are:
    - That the vehicle length, "L", be removed from the red formula; this yields:

$$AR = \frac{w}{v}$$

    - That, if the initial calculation results in an all red time greater than 3.0 seconds, the red time be recalculated as follows:

$$AR = \frac{1}{2}\left(\frac{w}{v} - 3\right) + 3$$

- That certain other guidelines should be applied when using the formula; they are:
    - That the clearance distance, "w" be taken to the far side of an exclusive right-turn lane, which is not a change from the current Signals and Geometrics Section practice.
    - That, in the presence of a crosswalk with pedestrian signals, the clearance distance be taken to the near side of the crosswalk;

        - That a crosswalk without pedestrian signals would not be considered when determining clearance distance
    - That for a "shared clearance" phase (when a phase serves multiple movements needing different clearance intervals), the following procedure should be applied:
        - Calculate each movement's clearance interval as if it had a dedicated phase.
        - Use the largest calculated Yellow, then subtract this Yellow from the largest Total Clearance to determine the All Red.
- That the proposed implementation of a recalculated red clearance interval of longer than 4.0 seconds is cause for a "stakeholder discussion" to provide advance notification and involvement to stakeholders and to provide an opportunity to consider possible countermeasures.

- The Task Force recommends this practice regarding the Red interval for the following reasons:
    - The procedure gives equal weight to safety concerns caused by long red times and safety concerns caused by short red times.
    - The procedure offers a smooth transition between "nominal" and "excessive" All-Red calculations.
    - Longer clearance distances will still receive a longer All-Red interval.
    - The method is easy to understand and apply.

The Task Force believes this clearance interval calculation procedure, when applied consistently, and not withstanding sound engineering judgment, will provide an efficient yet safe operating environment at signals.

The committees and the Task Force as a whole looked at a wide range of strategies, issues and options above and beyond what is discussed here. For a full appreciation of this, please refer to the minutes of the individual meetings.

I would like to thank the following persons for their exceptional hard work and kind assistance: the committee chairs, Frances Vess (Stantec), Don Bennett (City of Wilmington), Lisa Moon (PBS&J) and especially Steven Click of NCDOT.

If you have any further issues or discussion of this matter, please feel free to contact me.

Kindest regards,

David L. Jones, P.E.
Task Force Co-Chairman
NCSITE Traffic Engineering Council